REMARKS

Claims 7-14 are pending. Claims 7-14 are rejected. Claim 7 is amended. Support for the amendments can be found throughout the application, for instance in the specification and claims as originally filed. No new matter is added. Applicant respectfully requests reconsideration and withdrawal of all rejections.

Claim Rejections - 35 U.S.C. §103

Claims 7, 8, 11 and 12 are rejected under 35 U.S.C. §103(a) as being obvious over Horai et al. (US 6,113,687) or JP 11-199385 (hereinafter "JP 385"). It is alleged that it would have been obvious that when a wafer with an OSF ring on the periphery is placed in a boat, the OSF ring would contact the boat side.

Applicants respectfully disagree. The present invention as set forth in claim 7 concerns a silicon single crystal wafer which is a wafer prepared by means of a Czochralski method, the silicon single crystal comprising at least one portion formed of an OSF ring portion in a peripheral region of the silicon single crystal in contact with a boat on which the silicon single crystal is placed for heat treatment.

The present invention as set forth in claim 11 concerns a manufacturing process for a silicon single crystal wafer comprising the steps of: growing a silicon single crystal rod by means of a Czochralski method in a condition that an OSF ring region is formed in a

peripheral region of the silicon single crystal rod; and slicing the grown silicon signal crystal rod into silicon single crystal wafers.

In contrast to the claimed invention, Horai et al. discloses that by controlling the value of V/G so that the radius of OSF ring in the crystal surface is defined within a range of 70% to 0% of the crystal radius, see col. 5, lines 55-63, it is possible to prevent dislocation clusters in the outside zone of the OSF without lowering device characteristics. See col. 6, lines 41-45. In addition, JP 385 discloses a method for growing a silicon single crystal by Czochralski process, characterized by quenching near the solid-liquid boundary surface and a pulling rate such that the OSF ring is generated inward from the crystal periphery or may disappear in the crystal center part. See col. 3, lines 23-28; see also Abstract.

Applicant therefore submits that the claimed invention is neither taught nor suggested by any combination of the cited references. Applicant emphasizes that the claimed invention requires at least one portion formed of an OSF ring portion in a peripheral region of the silicon single crystal (claim 7) or that an OSF ring region is formed in a peripheral region of the silicon single crystal rod (claim 11). However, neither cited reference teaches or suggests forming an OSF ring in a peripheral region of a silicon single crystal, in accordance with the claimed invention. As noted above, while Horai et al. mentions an OSF ring formed at only 70% to 0% of the radius of the crystal wafer measured from the center (not at the periphery), see col. 5, lines 53-63, JP 385 teaches an OSF ring <u>inward</u> of the periphery. Accordingly, no combination of the cited references teaches or suggests an OSF ring in a peripheral region as claimed, and therefore, Applicant urges withdrawal of the rejection.

Moreover, Applicant submits that no *prima facie* case of obviousness has been established, since there is no motivation to modify or combine reference teachings, in accordance with the claimed invention. Applicant submits in particular that no reference provides motivation to form an OSF ring in a peripheral region of a silicon single crystal, as claimed. This can be seen from the location of OSF nuclei in the cited references. That is, as seen from the location of OSF nuclei, not only are both Horai et al. and JP 385 silent with respect to the suppression of slip dislocations at a contact portion between boat and silicon crystal wafer, those of ordinary skill in the art would recognize that neither reference is concerned with such suppression. Accordingly, the cited references fail to provide the requisite motivation, in particular motivation to form an OSF ring in a peripheral region of a silicon single crystal, as claimed.

Applicant emphasizes that in Horai et al., if the OSF ring were grown until visualized as a defect, degradation in device characteristics would result. See col. 6, lines 57-58. Accordingly, Horai et al. teaches that the growing of OSF nuclei can be suppressed, provided the oxygen concentration in the silicon single crystal is less than 8.5×10^{17} atoms/cm^3, see col. 6, lines 59-62, or the silicon single crystal is grown at a pulling rate of 1.0 mm/minute or more when the oxygen concentration is 8.5×10^{17} atoms/cm^3 or more. See 6, line 66 to col. 7, line 4. That is, in Horai et al., OSF nuclei do not exist out of the range of 70% to 0% of the radius of the crystal. Moreover, oxygen concentration is controlled at a lower level than a general wafer, and oxygen concentration in the periphery of the wafer is lower than in the middle. In contrast, the claimed invention may be seen in view of the following observations: since a silicon single crystal wafer prepared from a single crystal rod grown by means of a CZ method has lower oxygen concentration in the

peripheral region than in the middle (generating slip dislocations), a density of fine oxide precipitates serving as OSF nuclei can be increased in the peripheral region, thereby better suppressing slip dislocations. However, in Horai et al., it is quite clear that slip dislocations are apt to occur at a contact portion between boat and silicon crystal wafer, because the oxygen concentration in the peripheral region is at a lower level and OSF nuclei do not exist. Thus, considering the reference is silent with respect to the suppression of such slip dislocations, clearly Horai et al. provides no motivation regarding the claimed invention, in particular forming an OSF ring in a peripheral region of a silicon single crystal, as claimed.

Applicant also emphasizes that JP 385 discloses that since a vacant cluster inside of the OSF ring occurs if the OSF ring is generated at the crystal periphery, the rate of crystal growth is preferably 0.7 times of the maximum pulling rate or less, more preferably 0.6 times or less, in order to reduce the part occurring inside of the OSF ring. See col. 4, lines 28-30. JP 385 also discloses that if the rate of the crystal growth is 0.7 times the maximum pulling rate, the OSF ring is generated at a half distance in the crystal radius direction. See col. 2, lines 44-49. If the rate of crystal growth is 0.6 times the maximum pulling rate, the OSF ring may disappear into the crystal central part. Thus, in JP 385, it is most effective to control occurrence of the OSF ring at a half distance in the crystal radius direction to the crystal central part, and not at a peripheral region of the wafer. Accordingly, as with Horai et al, JP 385 provides no teaching or suggestion regarding the suppression of slip dislocations at a contact portion between the boat and the silicon crystal wafer. In the absence of such teaching or suggestion, JP 385 provides no motivation regarding the claimed invention, in particular forming an OSF ring in a peripheral region of a silicon single crystal, as claimed. Therefore, the rejection should be withdrawn.

Claims 9, 10, 13 and 14 are also rejected under 35 U.S.C. §103(a) as being obvious over Horai et al. or JP 385, in view of JP 11195565 (hereinafter "JP 565").

Applicant notes that claims 9, 10, 13 and 14 are dependent on claims 7 or 11. As discussed above, Horai et al. and JP 385 fail to teach or suggest each and every element of the claimed invention. Moreover, there is no motivation to combine or modify the reference teachings. It is pointed out that JP 565 fails to cure the deficiencies of Horai et al. and JP 385. Accordingly, claims 9, 10, 13 and 14 are allowable by virtue of at least their dependency on allowable claims 7 or 11.

Applicant also emphasizes that JP 565 has been cited for the motivation to add nitrogen to the disclosures of Horai et al. and JP 385. However, JP 565 discloses a silicon wafer produced by a method wherein the pulling rate of the single crystal from the raw material molten liquid is set at such a low level that an OSF ring is formed at a portion inward of the outer periphery of the crystal, or that the ring is eliminated at the central portion thereof, the nitrogen concentration being 1×10^{13} atoms/cm^3 or more. See Abstract. In other words, JP 565 discloses that with a nitrogen concentration of 1×10^{13} atoms/cm^3 or more, a vacant cluster is decreased inside of the OSF ring, and a dislocation cluster is eliminated outside of the OSF ring. See col. 4, lines 21-24. However, since it is difficult to eliminate all the vacant clusters, even though vacant clusters may be decreased inside of the OSF ring, it is preferable to control occurrence of the OSF ring so that the OSF ring is generated at a half distance in the crystal radius direction and the OSF ring is eliminated at the crystal central part. See col. 5, lines 8-16. Accordingly, as with both Horai et al. and JP 385, JP 565 is not concerned with, and provides no teaching or suggestion, the suppression of slip dislocations at a contact portion between boat and

silicon crystal wafer.

Moreover, in the present invention, it is preferable that the nitrogen concentration in a silicon single crystal wafer is in the range of 1×10^{10} to 5×10^{15} atoms/cm^3, more preferably in the range of 1×10^{12} to 5×10^{15} atoms/cm^3. This is because a wafer including such nitrogen content is more effective in suppressing the growth of slip dislocations, since the size of oxide precipitates is decreased and the density thereof increased due to the effects of nitrogen. However, JP 565 discloses that it is insufficient to suppress the occurrence of a vacant cluster, when the pulling rate of the single crystal is set at a lower level and the nitrogen concentration in the silicon single crystal wafer is less than 1×10^{13} atoms/cm^3. See col. 4, lines 21-24. In other words, the nitrogen concentration of JP 565 is disclosed for a purpose entirely different from that in the claimed invention, which concerns the suppression of slip dislocations at a contact portion between boat and silicon crystal wafer. Therefore, considering the absence of any teaching or suggestion regarding such suppression, JP 565 cannot be considered to provide any motivation to combine or modify reference teachings, in accordance with the claimed invention, in particular forming an OSF ring in a peripheral region of a silicon single crystal, as claimed. Therefore, Applicant urges that all rejections should be withdrawn.

In view of the amendments and remarks above, Applicant submits that this application is in condition for allowance and request favorable action thereon.

In the event this paper is not timely filed, Applicant hereby petitions for an appropriate extension of time. The fee for this extension may be charged to our Deposit Account No. 01-2300, along with any other additional fees, which may be required with respect to this paper, refereeing Attorney Docket No. 107242-00019.

Respectfully submitted,
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